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(54) **VACUUM FLUSH WASTE DISPOSAL
SYSTEM FOR RAILCARS**

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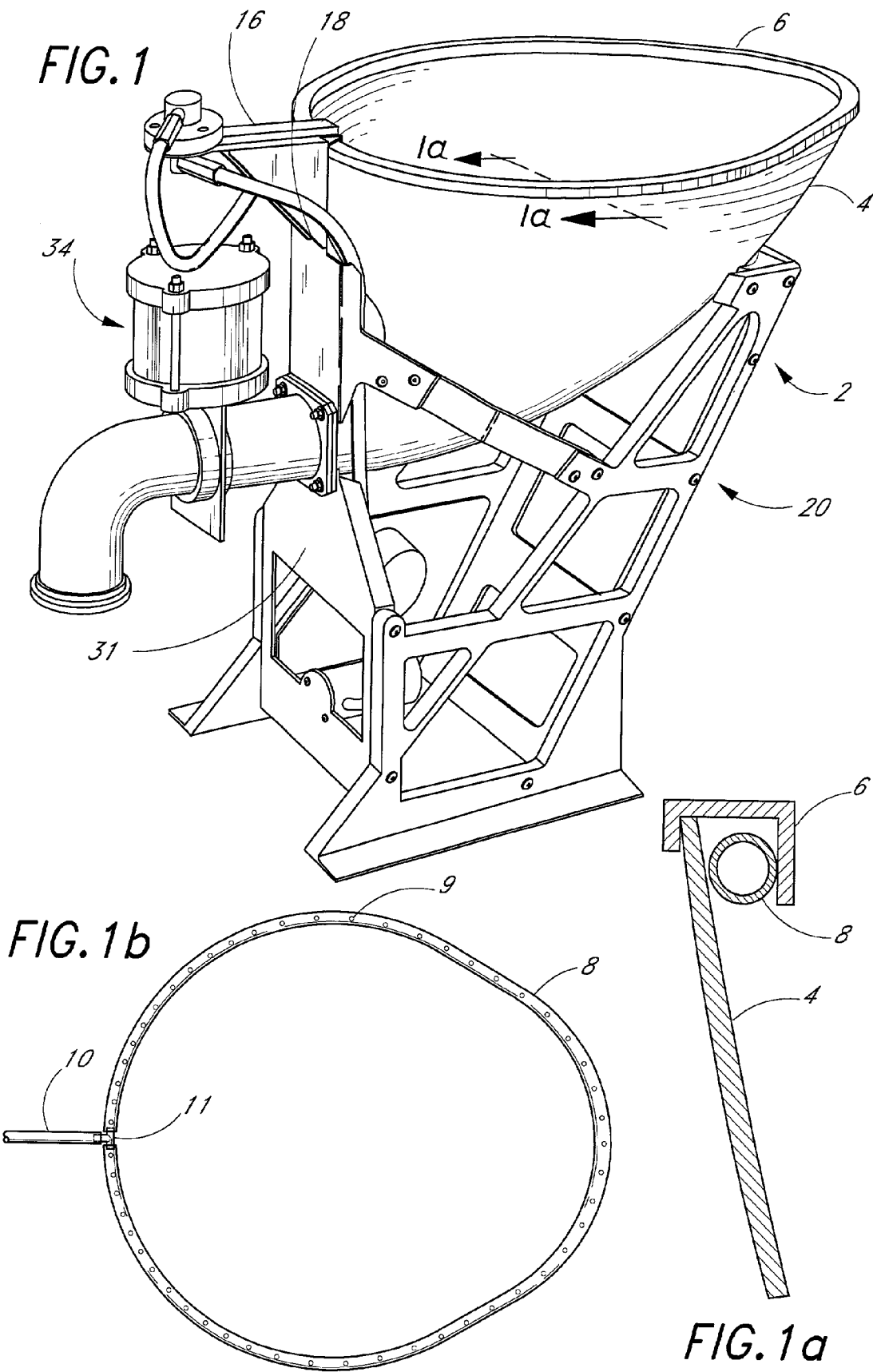
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(57) **ABSTRACT**

A vacuum-operated waste disposal toilet system suitable for use on commercial passenger vehicles, in particular railcars, including at least one bowl for receiving waste material and a full-retention waste-holding tank connected to the bowl by a drain line. A vacuum blower connected to the waste tank for creating a vacuum in the drain line. A flush valve assembly is provided in the drain line, and is selectively openable to connect the vacuum in the drain line to the bowl for sucking the waste out of the bowl. A disposable spray ring containing a plurality of holes, selectively coupled to a water source, is wedged between the bowl and a separate lip member for dispensing water onto the interior surface of the bowl. The flush valve assembly includes a vacuum-chamber with top and bottom vacuum inlet ports, a piston connected to a valve blade movable vertically within the chamber and a flush solenoid openable to selectively connect a second vacuum to the top and bottom inlet ports. The flush solenoid in the open position opens the valve blade, which in turn opens the flush valve assembly. The assembly is supported by a novel light weight composite base having a triangulated shape. The waste-holding tank contains a plurality compression load cells on the bottom exterior surface of the tank to accurately determine the capacity level of the tank.



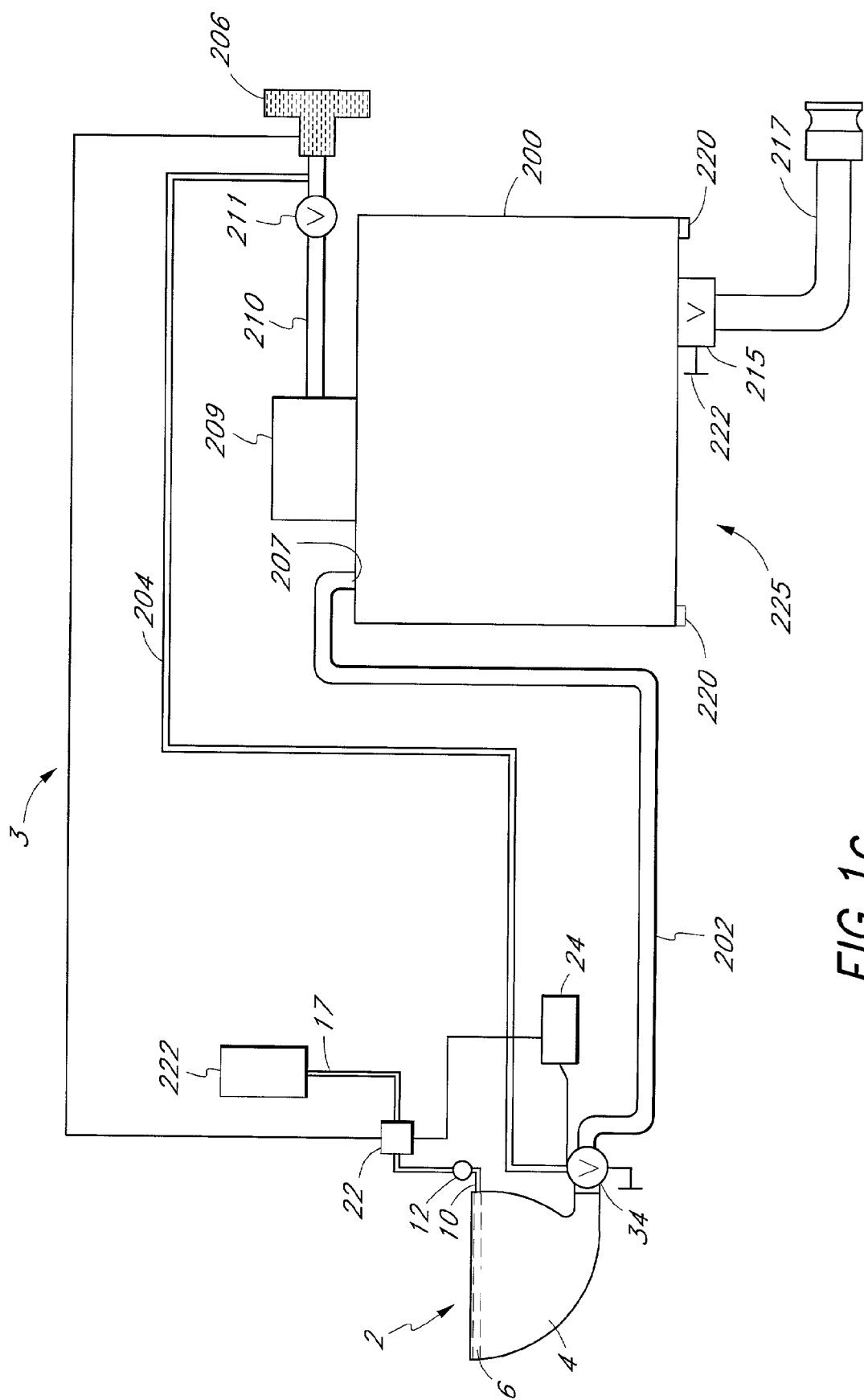
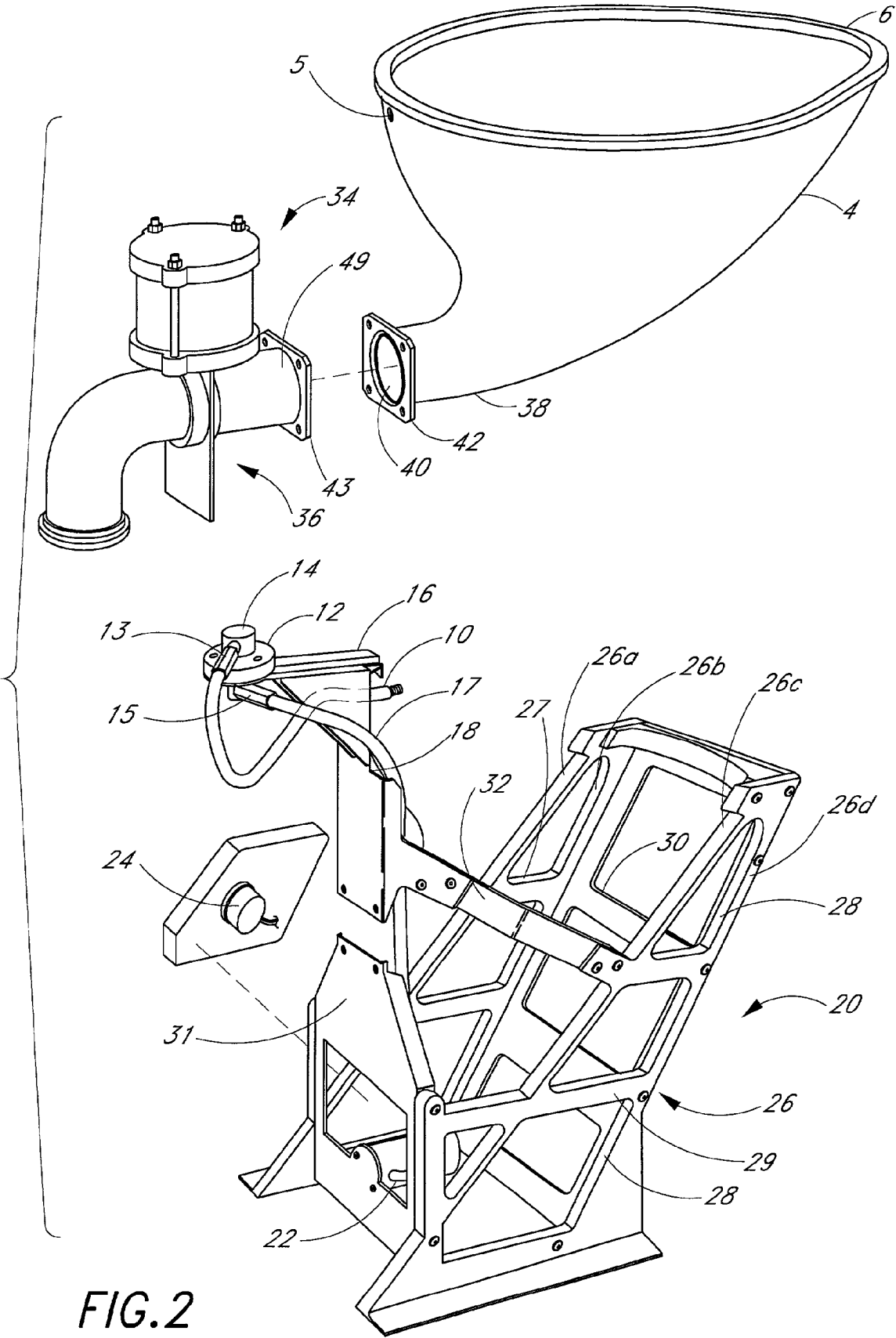
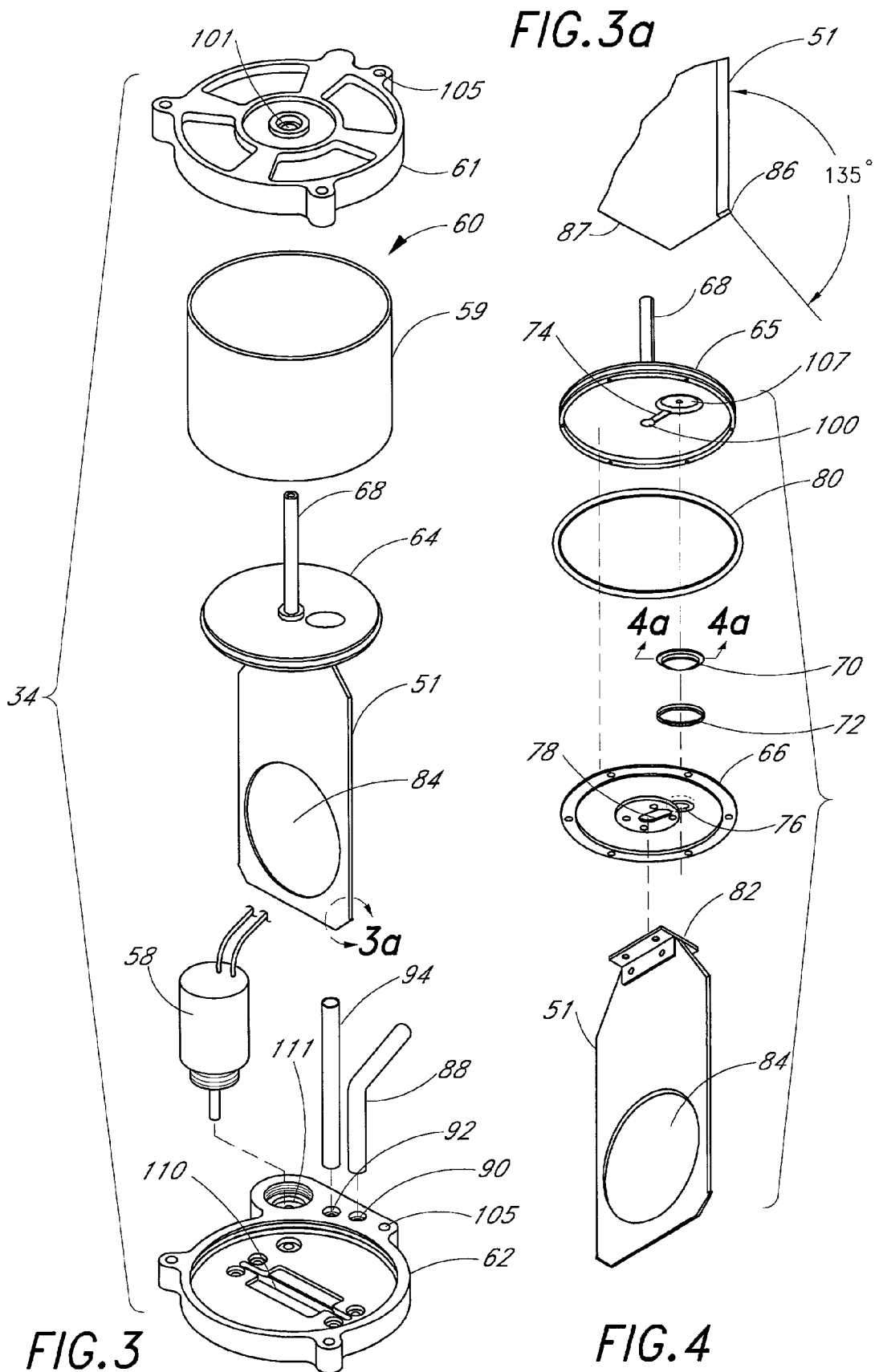
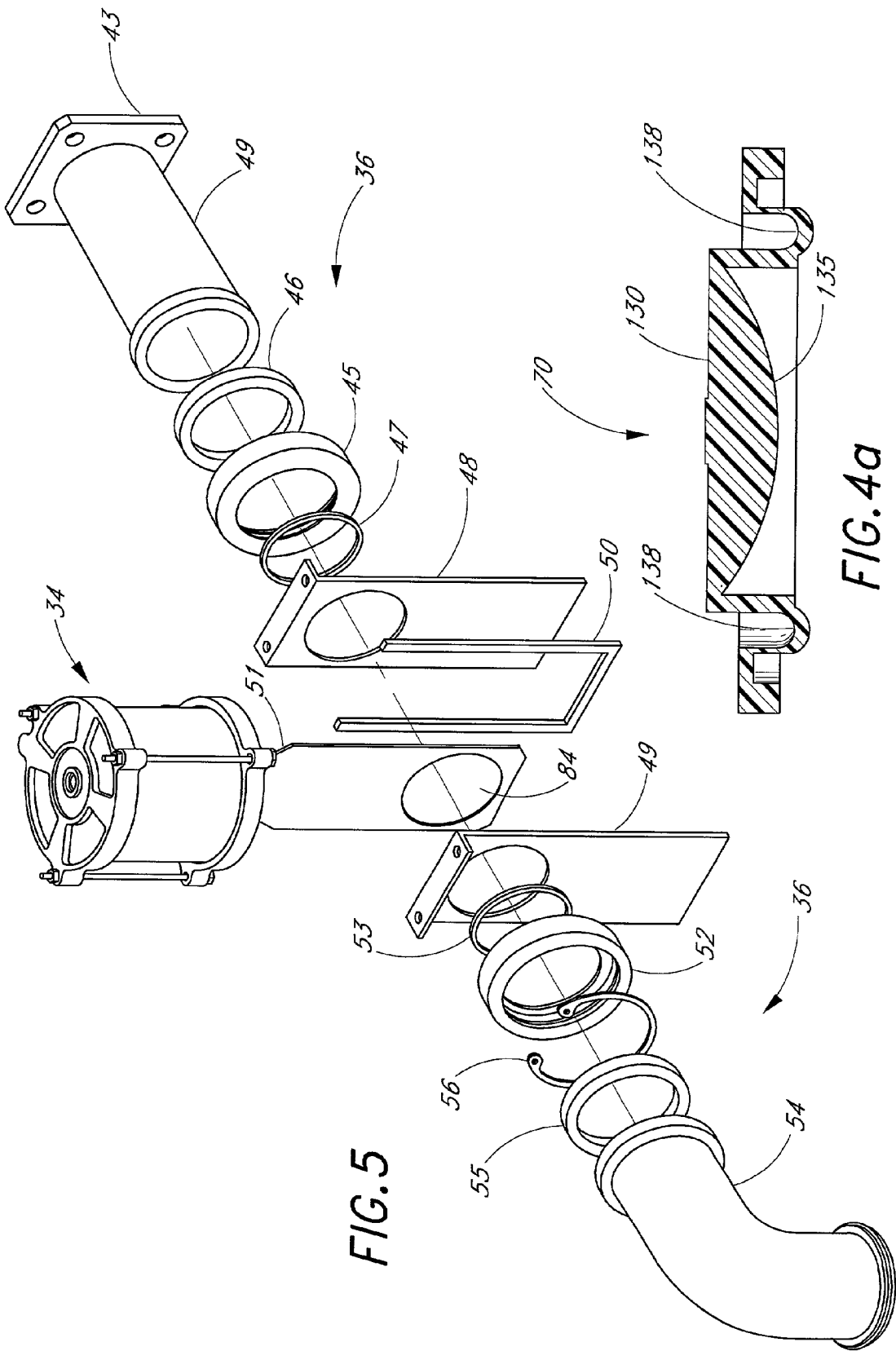


FIG. 1c







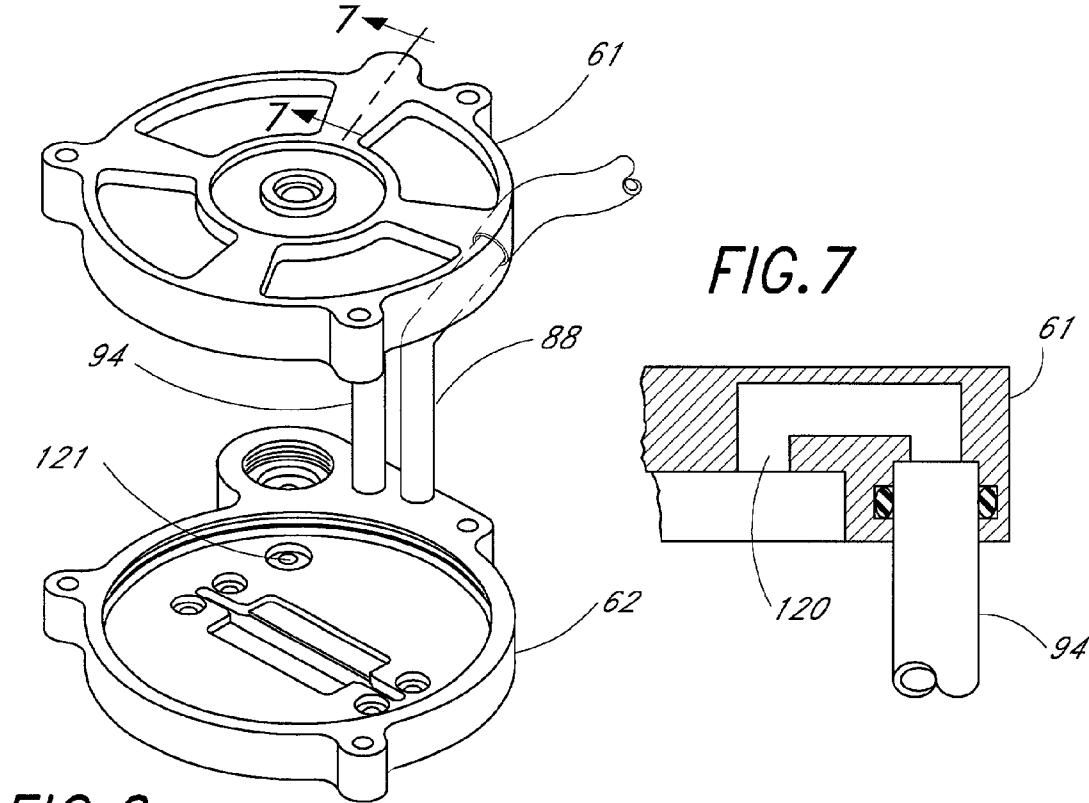


FIG. 6

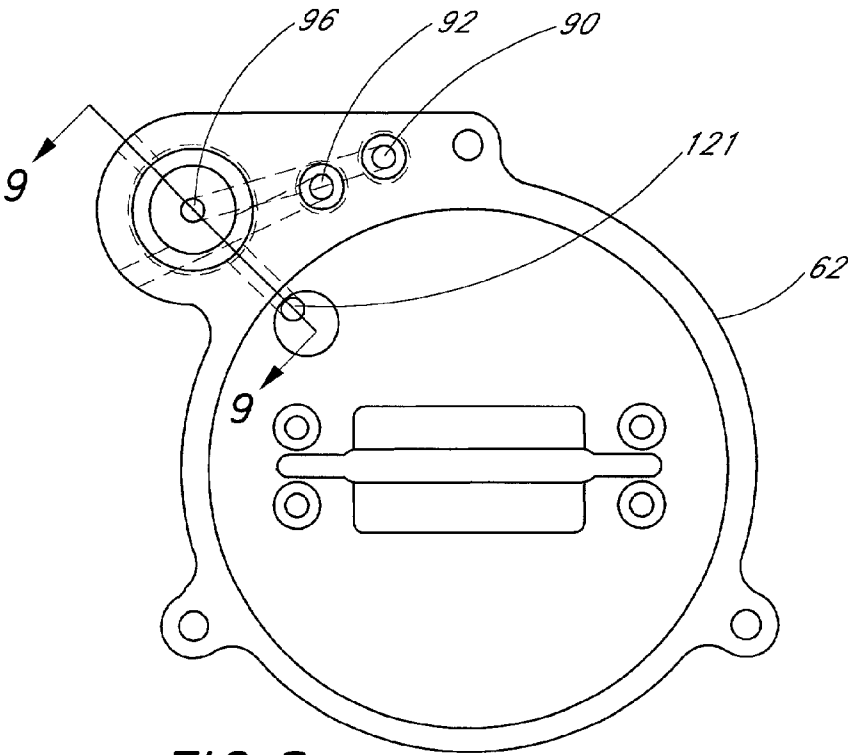


FIG. 8

FIG. 9

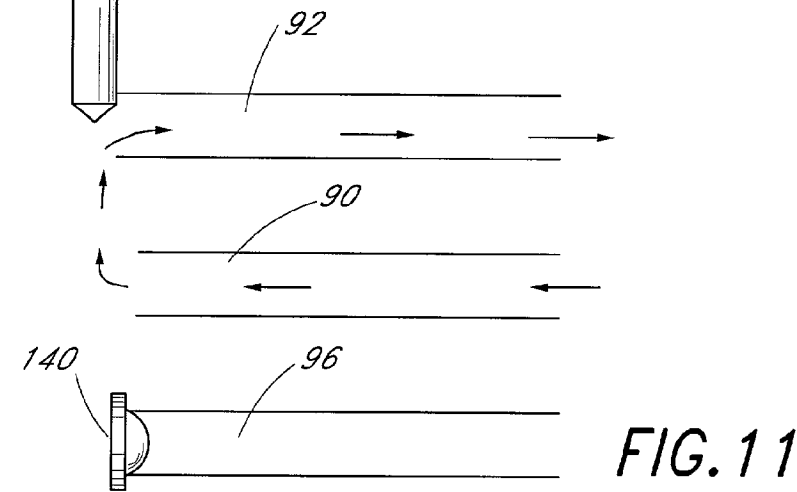
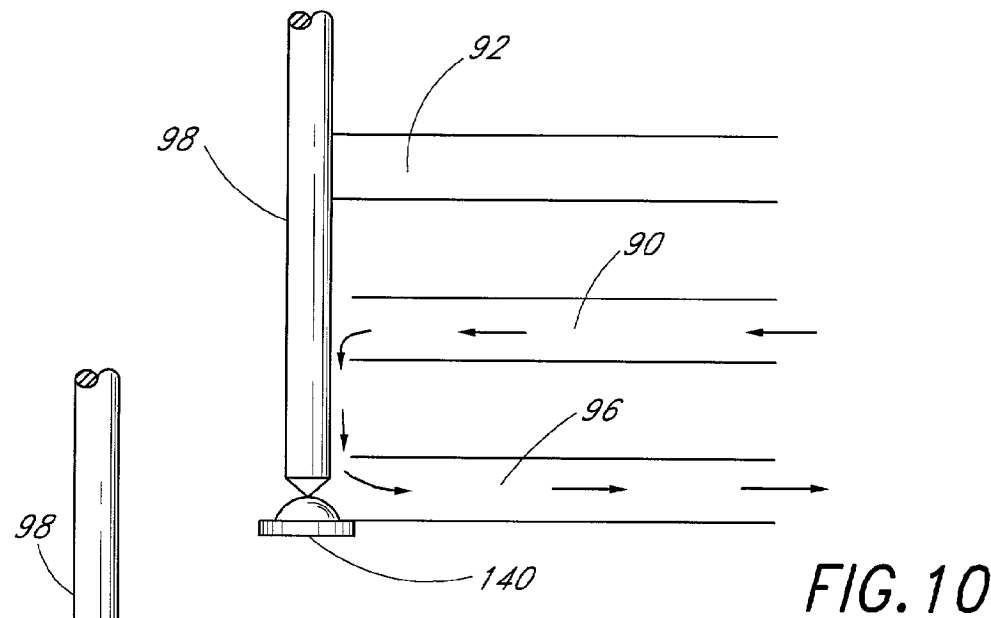
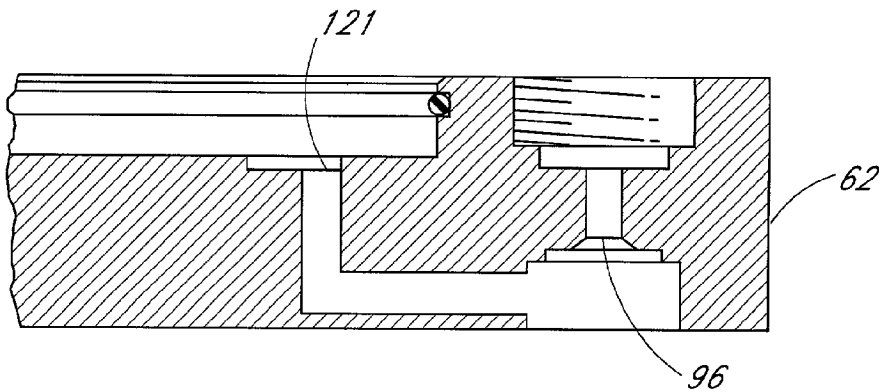
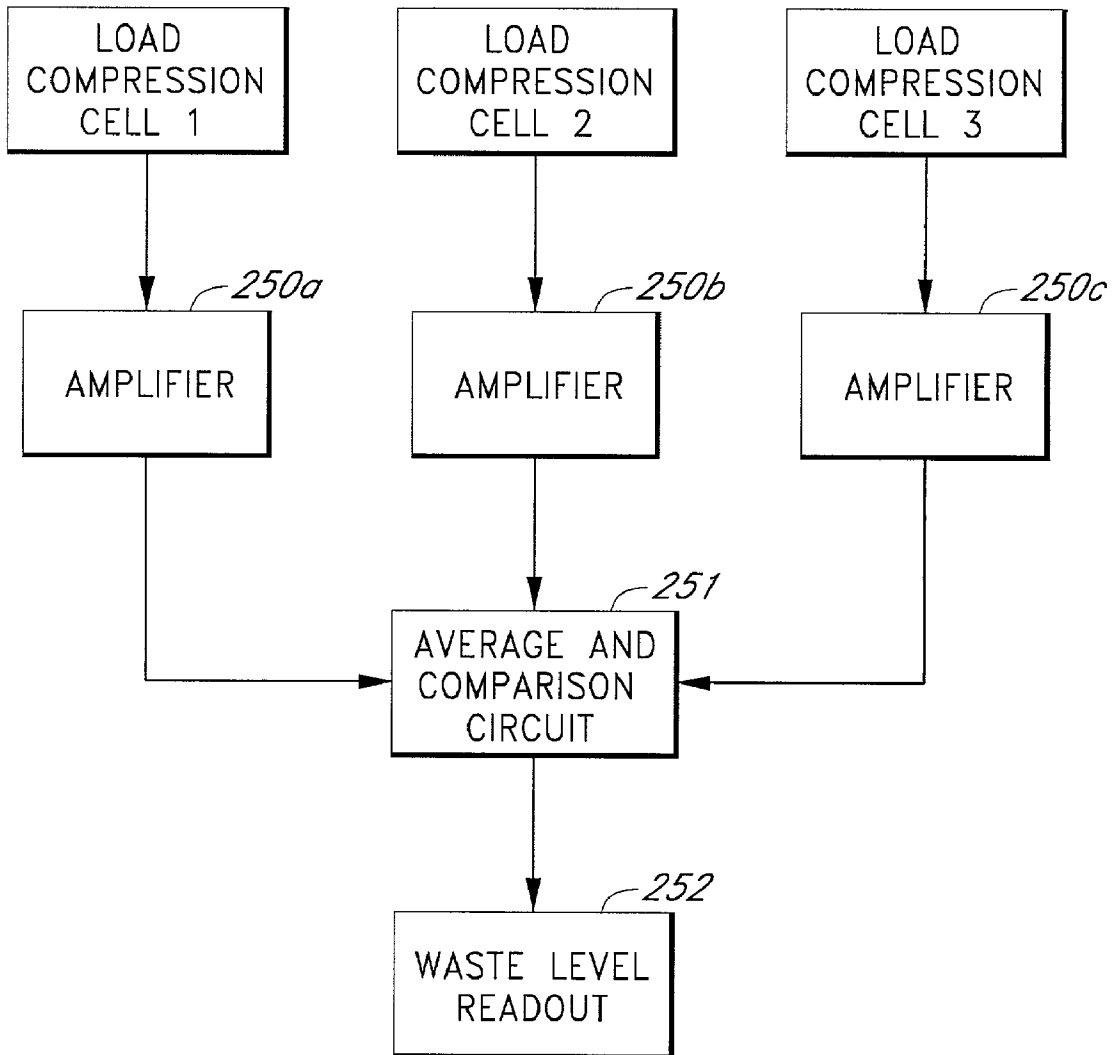


FIG. 12



VACUUM FLUSH WASTE DISPOSAL SYSTEM FOR RAILCARS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 08/276,952, filed Jul. 19, 1994, which is a continuation of U.S. patent application Ser. No. 07/862,320, filed Apr. 2, 1992.

BACKGROUND OF THE INVENTION

[0002] This invention relates to vacuum operated waste disposal systems used on passenger vehicles, in particular railcars.

[0003] The main components of such a waste disposal system are a toilet assembly comprising a flush valve assembly, a toilet bowl, a spray ring, a support base, a flush control unit; and a waste tank assembly comprising a waste holding tank with compression load cells in communication with the toilet bowl through a drain line. A preferred embodiment of a toilet assembly is described and claimed in a copending application, incorporated herein by reference, serial number (NORCAN.002A) filed on same date as the present invention and assigned to the Assignee of the present invention.

[0004] Prior art vacuum-operated waste tank assemblies for railcars are considered either recirculating, partial retention or full retention. Prior art recirculating assemblies do not contain a waste tank downstream to collect the waste. These prior art recirculating assemblies contain a number of disadvantages in that due to the lack of a waste tank, the prior art recirculating assemblies are very complex, requiring numerous pumps, valves, filtration units, and means for deodorizing and sanitizing the liquid waste used as the recirculating flushing fluid.

[0005] Prior art partial retention waste tank assemblies for railcars utilize a small partial retention waste tank which has the disadvantage of not being capable of retaining the waste material throughout the entire transit of the railcar. Once the prior art partial retention waste tank becomes filled, the waste is dumped out of the tank and into the environment during the course of the transit. These prior art partial retention waste tanks have the additional disadvantage of not being a fully enclosed system. These prior art partial retention waste tanks do not have the means to maintain a constant vacuum throughout the system even when the vacuum blower is not operative. This prevents the valve member, which selectively connects the bowl to the waste tank, from sealing the waste tank assembly from the toilet assembly. Thus, in partial retention systems, the foul odor from the waste tank is permitted to enter the lavatory.

[0006] The prior art full retention waste tank assemblies utilize a permanent waste tank capable of retaining the waste throughout the entire length of the transit. However, when prior art full retention waste tanks have been utilized, they have proven to cause a serious problem in use since they do not accurately measure waste collected in the interior of the tank. Thus, waste entering these prior art full retention waste tanks tends to explode and cake onto the outer surface of the waste level sensors. As a result, false readings or total waste level sensor failure is the result.

SUMMARY OF THE INVENTION

[0007] The preferred embodiment of waste disposal system for railcars includes a toilet bowl formed as a light-

weight composite member, a disposable spray ring, a valve assembly which contains no heavy motor driven parts or gear systems, a support base formed of a lightweight composite substance, and a full retention waste tank made out of composite material.

[0008] The waste tank contains a plurality of level compression load cells located on the bottom exterior of the tank. The compression load cells measure and compare the weight of the waste tank with and without the waste material to determine the level of the waste within the tank. Since these cells are not exposed to the waste material, they operate efficiently and accurately.

[0009] The present invention utilizes a novel method of measuring the amount of waste collected in the waste tank. The location of the compression load cells on the exterior of the waste tank protects the compression load cells from the effects of waste exposure, enabling the cells to last longer and give more accurate readings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a perspective view of the toilet assembly of the present invention;

[0011] FIG. 1a is a partial cross section of the bowl taken along lines 1a-1a of FIG. 1;

[0012] FIG. 1b is a top perspective view of the spray ring of the present invention;

[0013] FIG. 1c is a schematic representation of the vacuum-operated waste disposal system of the present invention;

[0014] FIG. 2 is an exploded view of the toilet assembly of FIG. 1;

[0015] FIG. 3 is an exploded view of the vacuum chamber of the present invention;

[0016] FIG. 3a is an enlarged partial view of the blade of FIG. 3.

[0017] FIG. 4 is an exploded view of the piston and valve blade combination of the present invention;

[0018] FIG. 4a is an enlarged cross-sectional view of the diaphragm of FIG. 4 taken along lines 4a-4a;

[0019] FIG. 5 is an exploded view of the waste outlet tubing in relation to the valve assembly of the present invention;

[0020] FIG. 6 is a perspective view of the top and bottom caps of the vacuum chamber of the present invention;

[0021] FIG. 7 is a partial cross-sectional view of the top cap taken along lines 7-7 of FIG. 6;

[0022] FIG. 8 is a top plan view of the bottom cap of the vacuum chamber of the present invention;

[0023] FIG. 9 is a partial cross-sectional view of the bottom cap taken along lines 9-9 of FIG. 8;

[0024] FIG. 10 is a schematic representation of the solenoid needle and flapper valve in relation to the vacuum ports when the flush solenoid of the present invention is in the closed position;

[0025] FIG. 11 is a schematic representation of the solenoid needle and flapper valve in relation to the vacuum ports, when the flush solenoid of the present invention is in the open position.

[0026] FIG. 12 is a schematic block diagram of how the waste tank level is determined.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] Referring to FIG. 1c, the present invention comprises a waste disposal system 3 including a toilet assembly 2 connected to a waste tank assembly 225 via a drain line 202. In the typical system, there will be one to twelve toilet assemblies 2 connected to a waste tank 200. However, for simplification, only one toilet assembly 2 will be described.

[0028] Referring to FIG. 1, the present invention comprises a toilet bowl assembly 2 which is light in weight and very sturdy. The assembly 2 comprises a very lightweight toilet bowl 4 advantageously constructed out of resin-impregnated fiber composite material. In the preferred embodiment, the composite material for the bowl 4 is woven fiberglass. As shown in FIG. 2, the bowl 4 has generally a funnel-like shape with a tubular bottom rear portion 38 of reduced diameter which represents the outlet for the waste contained in the bowl 4.

[0029] Referring to FIG. 1a, the top opening of the bowl 4 is connected to a separate lip or flange 6. This flange 6 will typically be made of plastic or stainless steel. The flange is placed circumferentially around the outer rim of the bowl 4 so that the flange 6 hangs over the bowl 4. In one embodiment, the bowl 4 and flange 6 are coated with a nickel-plated coating, which provides a very durable, abrasion-resistant, non-stick surface.

[0030] A disposable spray ring 8 is located between the bowl 4 and the flange 6. Ring 8 extends around the upper rim of the bowl 4 to provide an even spray pattern for bowl cleansing. Referring to FIG. 1b, in the preferred embodiment, the spray ring 8 is formed from a length of flexible plastic polyethylene tubing having two open ends with equidistantly spaced holes 9 for the emission of water onto the interior surface of the bowl 4. The tubing conforms to the shape of the rim of the bowl 4, with the two ends connected at the back of the interior of the bowl 4 to a single piece of plastic tubing 10 via a mating T-connector member 11. The spray ring 8 is simply wedged between the flange 6 and the bowl 4 for easy maintenance, as shown in FIG. 1a. The disposability of the spray ring 8 eliminates the need for frequent cleansing of the ring 8. When calcium and lime deposits form on the interior of the ring 8 from local water sources, the spray ring 8 is simply removed and disposed of and a new ring installed in its place.

[0031] Referring to FIG. 2, the back of the bowl 4 contains an opening 5 so that the tubing 10 can extend through the opening 5 and connect to a potable fresh water source 222 (shown schematically in FIG. 1c), which will supply the water necessary to cleanse the bowl 4.

[0032] The end of the tubing 10 away from the mating member 11 is connected to the output fitting 13 of an anti-siphon valve 12. The anti-siphon valve 12 only permits flow of water in one direction for sanitary purposes, so that waste water from the bowl 4 will not be able to travel from

the bowl 4 back through the plastic tubing 10 and into the potable fresh water source 222 (shown schematically in FIG. 1c).

[0033] The anti-siphon valve 12 advantageously includes an anti-freeze mechanism having a return conduit. As shown in FIG. 2, the output fitting 13 is connected to a plastic top 14 of the anti-siphon valve 12 which accumulates surplus water. One end of a rectangular shaft 16 containing two channels is connected to the bottom of the anti-siphon valve 12 for providing a passage for the water that has accumulated in the top 14 of the anti-siphon valve 12 and for preventing excess water from freezing inside of the top 14. The rectangular shaft 16 lies on top of a support member 18 of the support base 20, which will be discussed later. As shown in FIG. 1, the distal end of the shaft 16 is attached to the flange 6 and overhangs the rim of the bowl 4 so that the accumulated water is returned to the bowl 4.

[0034] Referring back to FIG. 2, the input fitting 15 of the anti-siphon valve 12, is connected via tube 17 to the outlet port of a rinse solenoid valve 22, which is attached to the rear of the support base 20. The input port of the rinse solenoid valve 22 is connected to the potable fresh water source 222. The rinse solenoid valve 22 in the closed position will not allow water from the potable fresh water source 222 to enter the spray ring 8. However, the rinse solenoid valve 22 when activated to its open position, will allow water to pass through the tubing 17, the anti-siphon valve 12, the tubing 10 and finally into the spray ring 8. The rinse solenoid valve 22 is activated by a timer/electronic control module 24 discussed below.

[0035] The bowl 4 of the present invention is supported by a novel support base 20 comprising a front sheet 30, a rear sheet 31 and side members 26 as shown in FIGS. 1 and 2. The bowl 4 is cradled by the support base 20 such that the front of the bowl 4 approximately half way down from the top of the bowl 4 rests on the front sheet 30 of the base 20 while the rear 38 of the bowl 4 is secured in between the rear sheet 31 of the base 20 and the support member 18 as shown in FIG. 1.

[0036] Referring to FIG. 2, the side members 26 of the support base 20 are generally in the shape of an obtuse, scalene triangle and formed by legs 26a, 26b, 26c and 26d made out of light weight composite material. In the preferred embodiment for railcar use, the composite material for these legs is shredded glass fiber impregnated with phenolic resin or anodized aluminum. The legs 26a and 26b are connected to each other by horizontal composite bars 27, while legs 26c and 26d are connected to each other by horizontal composite bars 29. The legs 26a, 26b, 26c, 26d and composite bars 27,29 define openings 28 in the side members 26 for an additional reduction in weight. The side members 26 are connected to each other in the front and back via stainless steel sheets 30, 31 for better lateral support. The front sheet 30 contains parallelogram-like openings and is larger than the rear sheet 31. The upper portion of legs 26a and 26c are connected to support bars 32, which in turn are connected to the support member 18 where the rectangular shaft 16, which was discussed earlier, is placed.

[0037] The advantages of having this particular design for the base 20 are numerous. For instance, when a shroud (not shown) eventually encases the support base 20 for aesthetic purposes, the slanted obtuse, scalene triangular shape of the

side members **26** create more room between the support base **20** and the shroud. This extra room is especially advantageous when work needs to be done on the toilet assembly **2**. In addition, the triangulated shape of the base **20** takes into account the center of gravity of the whole assembly **2** by compensating for the extra weight of the valve assembly **34** and the waste line tubing **36** (shown in **FIG. 1**) located behind the bowl **4**. The shape of the base **20** also provides for a better distribution of the weight of the bowl **4** by making contact higher up on the bowl **4** as opposed to prior bases. Finally, the fact of having the bowl **4** cradled by the support base **20** as opposed to being hard mounted, obviates the need for heavy metal doublers.

[0038] Referring to **FIG. 2**, the bottom rear of the bowl **38** contains an exit opening **40** which is connected to a waste outlet tubing **36** by means of a flange attachment. The rear **38** of the bowl **4** is secured to the top of the rear sheet **31** of the base **20** and the bottom of the support member **18** via the flange attachment, as shown in **FIG. 1**.

[0039] Referring to **FIG. 2**, a first mating flange **42** is adhesively attached onto the rear **38** of the bowl **4**. A second mating flange **43**, welded to one end of a piece of straight outlet tubing **49**, is screwed onto the first mating flange **42** with the top of the rear sheet **31** of the base **20** and the bottom of the support member **18** held in between as shown in **FIG. 1**.

[0040] The intended construction of the flush valve assembly **34** is shown in **FIGS. 3-8**. Referring to **FIG. 5**, the remainder of the waste outlet tubing **36** has the distal end of tube **49** welded onto a first large flange **45**, which is welded over a first small flange **46**. The first large flange **45** contains an interior groove in which a first spring loaded internal face seal **47** is located. This combination of a first large flange **45**, a first small flange **46** and a first internal face seal **47** is welded onto a first valve body **48**. The first valve body **48** is connected to a second valve body **49**. A U-shaped spacer **50** is in juxtaposition with respect to the valve bodies **48, 49**. The valve blade **51**, which will be discussed later, is slidable in between the opening of the spacer **50**.

[0041] The distal side of the second valve body **49** is connected to a second large flange **52**. The second large flange **52** contains a second internal face seal **53** located within an internal groove. Both face seals **47, 53** will make flush contact with the valve blade **51** so that no air or particles can get trapped between the valve bodies **48, 49**. The face seals **47, 53** utilized are a commercially standard unit containing an external circumferential groove where a continuously wound helical spring (not shown) is located. These springs are calibrated in a conventional manner by a manufacturer such as Ball Seal such that the seals **47, 53** will provide enough force onto the blade **51** to create a seal without impeding the blade's movement. The face seals provide a separate function of cleaning the surfaces of the blade **51** as the blade **51** slides up and down.

[0042] Finally, an elbow tubing **54** having one end welded onto a second small flange **55** is connected to the second big flange **52** via an internal spring ring **56**. The distal end of the elbow tube **54** is connected to the drain line **202** which is eventually connected to the full retention waste tank **200** which is discussed later, as shown in **FIG. 1c**. These types of components allow for quick connecting and disconnecting of the flush valve assembly **34** without the use of

conventional nuts and bolts. All the components utilized in the connecting of the waste outlet tubing **36** are advantageously made out of stainless steel.

[0043] Referring to **FIGS. 3 and 4**, the portion of the flush valve assembly **34** located on top of the waste outlet tubing **36** comprises a flush solenoid **58**, a vacuum chamber **60**, a piston **64**, and the valve blade **51**. The vacuum chamber **60** comprises a hollow cylindrical tube **59**, a top cap **61** and bottom cap **62**. The top and bottom caps **61, 62** are retained on the hollow tube **59** via threaded bolts extending through holes **105** and secured there by bolts (See **FIG. 5**).

[0044] The bottom cap **62** contains a slot **110** as shown in **FIG. 3**, so that the blade **51** can move freely in and out of the chamber **60**. The slot **110** contains a shop-made rubber gasket (not shown) with sufficiently close tolerances to seal the vacuum within the chamber **60**.

[0045] Furthermore, there are three openings located within the bottom cap **62**. A first vacuum port **90** located in the bottom cap **62** is connected to a pure vacuum source via vacuum line **204** (shown in **FIG. 1c**) via a metal inlet tube **88** as shown in **FIGS. 3 and 6**. A second opening **92** located on the bottom cap **62** is linked to a vacuum port **120** shown in **FIG. 7**, located in the top cap **61** via a second metal tube **94** which extends from the bottom cap **62** to the top cap **61** as shown in **FIGS. 3 and 7**. Finally, a third opening **96** shown in **FIG. 8**, located in the bottom cap **62**, is linked to a vacuum port **121** shown in **FIG. 9**, is also located in the bottom cap **62**.

[0046] Referring to **FIG. 1c**, the vacuum connected to tube **88** via vacuum line **204** is a pure vacuum since it is connected to a vacuum blower **206** via vacuum line **204** which is not connected to the waste tank **200**. The vacuum does not have to go through the waste tank **200** before entering the tube **88** (**FIG. 7**) so that there is no chance of fine particles of waste impeding the flow of vacuum.

[0047] The path taken by the vacuum within the flush valve assembly **34** is described with reference to **FIGS. 3, and 6-11**. In the description, the vacuum is sometimes referred to as a positive pressure source for ease of explanation. It is understood, of course, that the actual flow of air will be in the reverse direction. When vacuum is introduced through the tube **88** from a pure vacuum line **204**, the vacuum will take the following path: The vacuum will enter the first port **90** from the tube **88** and then proceed to the second opening **92**. As described in more detail hereinafter with respect to **FIGS. 10 and 11**, depending on whether the flush solenoid **58** is open or closed, the vacuum will either (i) bypass the second opening **92** or (ii) enter it and proceed to the vacuum port **120** located in the top cap **61** (**FIG. 7**). If the vacuum bypasses the second opening **92**, the vacuum will then pass to and through the third opening **96** and proceed to the vacuum port **121** located in the bottom cap **62** (**FIGS. 8 and 9**).

[0048] As shown in **FIGS. 3 and 4**, a plastic piston **64** in the shape of a disc is located within the interior of the chamber **60**. As shown in **FIG. 4**, the piston **64** contains an external circumferential groove where a commercially standard spring loaded face seal **80** is contained to seal the vacuum source either above or below the piston **64** within the chamber **60**.

[0049] Referring to **FIG. 4**, the piston **64** is made up of top and bottom circular pieces **65, 66** which are screwed

together. By way of specific example, the plastic material Ulten 2000 sold by General Electric is advantageously used for the pieces 65, 66 of piston 64. The center of the top piece 65 of the piston 64 contains a hole 100 affixed to a hollow air tube 68. As shown in FIG. 3, the top cap 61 contains a centrally located hole 101, through which extends the distal end of the tube 68 in sliding engagement. This distal end is exposed to outside ambient air and as described below, this tube 68 enables an interior cavity 74 of the piston 64 to be exposed to the outside ambient air.

[0050] Referring back to FIG. 4, the interior of the top piece 65 of the piston 64 contains a recess 107 located radially outward from the hole 100 for the placement of a circular diaphragm 70 which is discussed in detail below. The diaphragm 70 is kept in the recess 107 by a retainer 72. The recess 107 is connected to the bottom hole 100 via a first recessed slot or cavity 74 located on the interior lower-surface of the top piece 65 of the piston 64.

[0051] The interior upper surface of the bottom piece 66 of the piston 64 contains a second through opening 76 located adjacent to the diaphragm 70 when the top and bottom pieces 65, 66 of the piston 64 are screwed together. The center of the bottom piece 66 of the piston 64 which is in juxtaposition with the bottom hole 100, and the second opening 76 are connected via a second recessed slot 78 located on the bottom piece 66 which will create a channel or cavity within the piston 64 when mated with the first recessed slot 74 located on the interior surface of the top piece 65.

[0052] As shown in FIG. 4a, the diaphragm 70 is a flexible rubber disc having a main portion capable of moving in or out of the recess 107. The main portion of the diaphragm 70 has a substantially flat side 130 which is juxtaposed in close proximity to the recess 107 and a semi-circular opposite side 135 spaced away from the recess 107. The retainer 72 is secured to the diaphragm 70 via a circumferential groove 138 around the main portion of the diaphragm 70. The area between the main portion and the groove 138 is flexible to allow the main portion of the diaphragm 70 to either move toward or away from the recess 107. When a vacuum is created above the piston 64, the main portion of the diaphragm 70 will move toward the recess 107 and away from the second opening 76 such that the flat side 130 will be flush with ceiling of the recess 107 and the semi-circular side 135 will be distanced from the opening 76. This permits ambient air to flow through tube 68 from outside the top cap 61 to the second opening 76 and into the bottom portion of the chamber 60.

[0053] When a vacuum is created above the piston 64, the main portion of the diaphragm 70 will move away from the recess 107 and toward the opening 76 such that the flat side 130 will be distanced from the ceiling of the recess 107 and the semicircular side 135 will be flush against the opening 76. When the diaphragm 70 blocks the opening 76, ambient air cannot escape from the tube 68 and the cavity 74 to the bottom of the chamber 60 below the piston 64. Otherwise, the vacuum created beneath the piston 64 would suck the ambient air from outside the chamber 60 through the tube 68 and the opening 76. Thus, the diaphragm 70 closes off the opening 76 as discussed previously to create a suction causing the piston 64 to descend.

[0054] Referring to FIG. 4, a flexible valve blade 51 made out of stainless steel is connected to the bottom 66 of the

piston 64 via a gasket 82, creating a unitary body. The piston 64 is attached substantially perpendicular to the valve blade 51. When the piston 64 rises, the blade 51 rises also.

[0055] The blade 51 contains a circular port 84 which will coincide with the interior bores of the waste line tubing 36 when the blade 51 is raised as shown in FIG. 5. The blade 51 is slidably retained within the opening of the spacer 50 as discussed earlier. The outside width of the blade 51 is less than the inside width of the spacer 50. The spacer 50 and the blade 51 have approximately the same thickness.

[0056] A significant feature of the invention is that the flush valve assembly 34 is a self-cleaning unit. Referring to FIG. 3a, the blade 51 contains notches 86 on both ends of its bottom edge 87 which automatically cleans the face seals 47, 53. As noted above, the face seals 47, 53 reciprocally clean the surface of the valve blade 51 each time the valve blade 51 is actuated.

[0057] Referring back to FIG. 3, a flush solenoid 58 is connected to the chamber 60 via an opening 111 on the bottom cap 62. In the preferred embodiment, the solenoid 58 comprises a cylindrical shell having a needle element 98 and a circular flapper valve 140, shown schematically in FIGS. 10 and 11. The solenoid 58 is actuated by the control module 24 which is discussed later.

[0058] Referring to the schematic FIGS. 10 and 11, the vacuum path, in relation to the openings 90, 92, 96 located in the bottom cap 62 of the chamber 60, has been simplified. When the solenoid 58 is in the closed position as shown in FIG. 10, the solenoid needle 98 blocks off the second opening 92 so that the vacuum source of the first port 90 is connected only to the third opening 96 which will create a vacuum in the bottom of the chamber 60 through the port 121 located in the bottom cap 62. This will cause the piston 64 to either move down in the chamber 60 or, if the piston 64 is already at the bottom of the chamber 60, the piston 64 will remain so. When the solenoid 58 is in the open position as shown in FIG. 11, the needle 98 will move up causing the flapper valve 140 to pivot or tilt due to the air movement and block the third opening 96. Now the vacuum from the first port 90 is only connected to the second opening 92 which is linked to the port 120 located on the top cap 61 (FIG. 7). This will create a vacuum in the top of the chamber 60 causing the piston 64 to move upwardly.

[0059] It will thus be seen that the novel flush valve assembly 34 of the present invention is of relatively simple construction with relatively few parts. For instance, the lowering of the piston 64 to the bottom of the chamber 60 is achieved by the diaphragm and the air contained in the tube 94. Another feature of the invention is that during the descent of the piston 64, the ambient air that was contained in the tube 94 will bleed into the top portion of the chamber 60 above the piston 64, to eliminate the vacuum that was created there earlier, allowing the piston 64 to rapidly descend down in the chamber 60. Likewise, during the rise of the piston 64, the tube 68 enables the area beneath the piston 64 to fill with ambient air so that the force of the vacuum that is created above the piston 64 will not be impeded by a counteracting vacuum force located beneath the piston 64.

[0060] Referring back to FIG. 2, located in between legs 26a and 26b of the support base 20 is a timing mechanism/

control module **24** of the type well known in the prior art. The timing mechanism/control module **24** establishes when the solenoids **22**, **58** should open and close. The control module/timing mechanism **24** controls the operation of the toilet assembly **2** through sequenced micro-switches.

[0061] Referring to **FIG. 1c**, the full retention waste tank **200** of the present invention is advantageously a cylindrical housing made out of composite material with a holding capacity of 200 gallons. The tank **200** is fabricated from a cross-linkable polyethylene material using a rotational molding process. In the preferred embodiment, the material for the tank **200** is a glass reinforced thermoplastic. This material has proven to be extremely durable and puncture resistant. The cylindrical shape of the tank **200** removes the need for internal baffling. The molding method combined with the tank shape eliminates the chances of tank failure due to a failure of weld seams. A commercially standard, flexible heating blanket (not shown) containing internal heating coils encasing the entire tank **200** (not shown) may be added to prevent freezing of the waste material. In the preferred embodiment, the waste tank **200** contains sprinklers (not shown) to selectively wash the internal sides of the tank **200** to assure proper cleaning and to prevent waste build-up.

[0062] A pressure transducer switch (not shown) in the form of a commercially standard, pressure transducer switch is advantageously connected to an outlet port of the tank **200**. This switch measures the pressure level within the tank **200** at all times so that a constant pressure is maintained throughout the system. When the pressure level sensed by the pressure transducer switch decreases below a certain level, the pressure transducer switch will automatically turn on the vacuum blower **206** to maintain a constant level of vacuum. Maintaining a constant negative vacuum pressure at all times creates a faster flushing cycle due to the fact that when a flush cycle is initiated, the vacuum is already present to flush the waste. In addition, the vacuum created by the pressure transducer switch will suck the valve blade **51** of the valve assembly **34** toward the face seal **53** (shown in **FIG. 5**) sealing this side of the interior bore of the waste outlet tubing **36** from the toilet assembly **2** so that foul odor from the waste tank **200** will not permeate the lavatory modules.

[0063] The top of the tank **200** has an inlet opening **207** wherein the drain line **202** carrying the waste enters. Attached to the top side of the waste tank **200** is a commercially standard water separator **209** used to separate air from water and waste. There is an opening (not shown) which connects the waste tank **200** to the inlet of the water separator **209**. Air that is sucked out of the tank **200** by the vacuum blower **206** first passes through the water separator **209** before it reaches the blower **206**. This water separator **209** prevents the flow of moisture from the waste to enter and damage the blower **206** when the blower **206** is sucking the air through the waste tank **200**.

[0064] The outlet of the water separator **209** is connected to a commercially standard in-line blower check valve **211** which is a one-way check valve permitting air to flow out of the tank and preventing airflow in line **210** into the tank. The outlet of the check valve **211** is connected to the vacuum blower **206** by the same tube **210**. Thus, the check valve **211** prevents ambient air from outside the system to proceed

through the blower and enter the waste tank **200**. Thus, when the blower **206** is turned off, this valve **211** closes and the vacuum within the system will be maintained.

[0065] The bottom side of the tank **200** contains an outlet opening connected to a waste dump valve **215** for discharging the waste after the completion of the trip. In the preferred embodiment, there is a manual release mechanism **232**, well known in the industry, for manually opening the waste dump valve **215**. The outlet of the waste dump valve **215** is connected to a standard tank drain tubing **217**.

[0066] Referred again to **FIG. 1c**, the bottom exterior of the tank **200** is supported on two or more compression load cells **220** for monitoring the capacity level of the tank **200**. These cells **220** are located on the exterior of the tank. Typically, the tank **200** of the present invention will have between three and five compression load cells **220** placed at advantageous locations on the bottom exterior of the tank **200** of which two such cells are shown. These cells **220** are a commercially standard unit manufactured by a company such as Transducer Technics.

[0067] The waste level in of the tank **200** is determined by how much the load cells **220** are compressed. Referring to the block diagram of **FIG. 12**, three compression load cells **220** have been shown by way of example. The individual compression load cells **220** are connected by electronic amplifiers **250a**, **250b**, and **250c** to an average and comparison circuit **251** shown schematically in **FIG. 12**, which will average out the readings from the various compression load cells **220** and then compare that mean value with the weight of an empty tank **200** to determine the waste level within the tank **200**. The average and comparison circuit **251** derives this value by comparing the average detected compression of the load cells **220** as compared to their average compression by an empty tank **200** and provides a readout of the waste level within the tank **200** at waste level readout **252**. Readout **252** alerts the conductor of the railcar when the tank **200** is approaching full capacity.

[0068] The exterior placement of the compression load cells **220** prevent the waste material from attaching itself onto the cells **220**, causing the cells **220** to either break down or give false readings.

[0069] In the preferred embodiment, the waste tank **200** is initially installed onto the railcar via a method well known in the industry, using a pallet (not shown). The pallet is a metal frame that supports and encases the bottom of the waste tank **200**. The pallet is designed to be moved by forklifts or other lifting equipment. All plumbing for tank draining is advantageously attached to the pallet base. Plumbing is designed to allow tank draining from either side of the car. The lower end of the waste tank **200** is secured by known techniques, such as welding and/or bolting, to the load cells **220**, which are in turn secured by known techniques such as welding and/or bolting to the pallet. The pallet is then secured, again by welding and/or bolting, to the floor of the railcar.

[0070] The full retention waste tank **200** with the externally located compression load cells **220** of the present invention presents a waste tank assembly **3**, capable of accurately monitoring the operation of the system.

[0071] In operation, when the user depresses the flush button located on the lavatory module (not shown), a signal

will activate the vacuum generator **206** while simultaneously initiating the toilet flush cycle. The vacuum generator **206** when turned on will reinforce the vacuum already present in the drain line **202** and in the pure vacuum line **204**.

[0072] The control unit **24** of the individual toilet assembly **2** will then alert the rinse solenoid **22** to actuate into the open position. This will allow water from the potable fresh water source (**222**), as shown in FIG. 1c, to proceed through the plastic tubing **17**, through the anti-siphon valve **12**, through the plastic tubing **10**, through the spray ring **8** and out onto the interior surface of the bowl **4**, dispensing **12-14** ounces of water. The amount of water and the placement of the holes **9** on the spray ring **8** should be able to fully rinse the interior surface of the bowl **4**.

[0073] Then the control module **24** will alert the rinse solenoid **58** to close, thus shutting off the water supply to the bowl **4**. This rinse cycle will take at most two seconds. One second after the initiation of the rinse cycle, the control module **24** will alert the flush solenoid **58** to actuate to the open position. Initially, the piston **64** will be located at the bottom of the chamber **60** due to the fact that the flush solenoid **58** is closed and that there is a constant vacuum present throughout the system even when the vacuum generator **206** is not activated due to the vacuum switch and the in-line check valve **211**.

[0074] However, when the flush solenoid **58** is activated open, the needle **98** will move up, causing the flapper valve **140** to tilt and close off the third opening **96** linked to the bottom port **121** as shown in FIG. 11. The pure vacuum from the vacuum line **204** will enter the bottom cap **62** of the chamber **60** via the first port **90**. The vacuum will then enter the second opening **92** linked to the second port **120** located in the top cap **61** via tube **94**. This will create a vacuum in the top of the chamber **60**, causing the piston **64** to rise.

[0075] As the piston **64** rises, ambient air will proceed through the tube **68** and then through the channel created by the recessed slots **74, 78**, eventually bleeding off through the second opening **76** to an area below the piston **64** due to the fact that the diaphragm **70** is not blocking the opening **76**.

[0076] When the piston **64** moves up, since it is connected to the valve blade **51** via the gasket **82**, the blade **51** will move up through the slot **110** of the bottom cap **62**. The lift of the blade **51** will cause the port **84** on the valve blade **51** to coincide with the interior bores of the waste line tubes **36**. Thus, the vacuum contained in the drain line **202** will suck the waste located in the toilet bowl **4** out to the waste tank **200**. The flush solenoid **58** will remain open for approximately four seconds, allowing sufficient time for complete cleaning of the drain line **202** between the bowl **4** and tank **200**.

[0077] Once the four seconds are up, the timing mechanism/control module **24** will close the flush solenoid **58**. The closing of the flush solenoid **58** will cause the needle **98** to move down and block the second opening **92** linked to the port **120** in the top cap **61**, as shown in FIG. 10. The flapper valve **140** will tilt back down, opening the third opening **96** which is linked to the port **121** located in the bottom cap **62**. The needle **98** will eventually come to rest on top of the flapper valve **140**, as shown in FIG. 10.

[0078] Now the vacuum located in the first port **90** will be redirected to the third opening **96**, which is linked to the bottom port **121**, creating a vacuum below the piston **64** in

the bottom of the chamber **60**. This will cause the piston **64** to move down. The main portion of the diaphragm **70** during the descent will move outward from the recess **107** of the top piece **65** such that it will block the second opening **76** on the bottom piece **66**. Now ambient air from the air tube **68** will not be able to enter below the piston **64**. As discussed earlier, the closing of the diaphragm **70** will allow a vacuum suction to be created below the piston **64**, causing the piston **64** to descend. Air that was located in the tube **94** linking the second opening **92** to the port **120** on the top cap **61** will now bleed into the area above the piston **64** in the top of the chamber **60** facilitating the descent of the piston **64** along with the air tube **68**. The lowering of the piston **64** will thus lower the blade **51**, moving the opening **84** of the valve blade **51** away from the interior bores of the waste line tubes **36**, thus closing off the vacuum suction to the bowl **4**.

[0079] The control module **24** will then send a signal to shut off the vacuum generator **206** approximately six seconds after the start of the flush cycle. The flush cycle is now complete and ready for another cycle.

[0080] The present invention discloses a novel, vacuum-operated flush waste toilet system, including a novel lightweight toilet assembly utilizing a valve assembly having relatively few moving parts. The present toilet assembly uses lightweight, yet strong composite material for many of the components of the assembly. Furthermore, the novel design of the support base provides for a more secure support of the toilet bowl. The composite materials used in this invention are substantially lighter in weight than their prior art counterparts. The reduction in the overall weight of the toilet assembly will lead to a substantial reduction in operation costs when the invention is used aboard commercial vehicles.

[0081] The present invention likewise discloses a novel apparatus and method for monitoring the waste level of a full retention waste tank utilizing compression load cells located on the exterior of the waste tank. The exterior placement of the compression load cells eliminates the chance of false readings and cell breakdown due to waste exposure.

What is claimed is:

1. A vacuum-operated flush waste disposal toilet system for railcars comprising:

a full retention composite waste holding tank;

vacuum operated means to transfer an amount of waste matter received in a bowl to said tank;

a plurality of compression load cells located on a bottom exterior of said tank; said cells not coming into contact with the waste so as to give more accurate readings of the level of waste contained in said tank;

a disposable spray ring for supplying rinse water to said bowl, said spray ring having a disposable hollow tube selectively coupled to a source of water and having a plurality of openings for dispensing the water directly from said ring onto the interior surface of said bowl;

means to maintain a constant vacuum source within said waste tank to provide for a rapid flush cycle; and

means for averaging and comparing a value received from said cells to calculate the waste level of said tank.

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